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IS 10773 (1995): Wrought Copper Tubes for Refrigeration and Air-Conditioning Purposes [MTD 8: Copper and Copper Alloys]



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भारतीय मानक

प्रशीतन और वातानुकूलन प्रयोजनों के लिए पिटवां तांबे की
नलिकाएँ — विशिष्ट

(पहला पुनरीक्षण)

Indian Standard

WROUGHT COPPER TUBES FOR
REFRIGERATION AND AIR-CONDITIONING
PURPOSES — SPECIFICATION

(*First Revision*)

UDC 669.3-462 : 621.56/.59

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FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Copper and Copper Alloys Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was published in 1983. In this revision following modifications have been made:

- a) Title and scope have been modified to cover tubes for air-conditioning and also tubes in coil form.
- b) Requirements of process of manufacture and end sealing of tubes have been included.
- c) One more grade of copper 99.85 percent minimum has been included. Chemical composition of other existing grade has been modified.
- d) Requirements of 0.2 percent proof stress has been included. Tensile strength and percentage elongation of new grade have been included and of existing grade have been modified.
- e) Requirement of tolerance on eccentricity, ovality, roundness and straightness have been included.
- f) Requirements of mercurous nitrate test has been deleted.
- g) Requirements of flattening test and drift expanding test have been modified.
- h) Requirements of non-destructive testing have been modified.
- j) Requirements of sampling and criteria for conformity and retest have been modified.
- k) Requirement of packing has been modified.
- m) Requirement of test certificate has been added.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the results of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

WROUGHT COPPER TUBES FOR REFRIGERATION AND AIR-CONDITIONING PURPOSES — SPECIFICATION

(First Revision)

1 SCOPE

This standard covers the requirements of solid drawn (seamless) copper tubes in straight length or coil form for air-conditioning and refrigeration purposes.

2 REFERENCES

The Indian Standards listed at Annex A are necessary adjuncts to this standard.

3 TERMINOLOGY

3.1 For the purpose of this standard the following definitions as given in IS 3288 (Part 3) : 1986 shall apply.

3.1.1 *Seamless Tube (Solid Drawn Tube)*

Tube produced from a tube shell by drawing.

3.1.2 *Tube Shell*

A hollow cylinder produced by extrusion, rotary piercing, or casting for subsequent drawing into tube.

3.2 In addition to above following definitions shall also apply.

3.2.1 *Bunched*

A coil in which the turns are bunched and held together such that cross-section of the bunched turn is approximately circular.

3.2.2 *Eccentricity*

$$\text{Eccentricity} = \frac{t(\text{Max}) - t(\text{Min})}{t(\text{Average})}$$

where t is wall thickness of the tube.

3.2.3 *Level or Transverse Wound Coil*

A coil in which the turns are wound into layers parallel to the axis of the coil such that successive turns in a given layer are next to one another (also called helical coil).

3.2.4 *Mean Outside Diameter*

Half the sum of two diameters measured in the mutually perpendicular directions at any one cross-section of a tube.

3.2.5 *Mean Wall Thickness*

Half the sum of two wall thicknesses at points diametrically opposite to each other at any one cross-section of a tube.

3.2.6 *Ovality*

$$\text{Ovality} = \frac{D(\text{Max}) - D(\text{Min})}{D(\text{Average})}$$

where

D is outside diameter of the tube.

NOTE — Before bending for a bent tube.

3.2.7 *Out of Roundness*

$$\text{Out of roundness} = D(\text{Max}) - D(\text{Min})$$

3.2.8 *Pipe/Tube*

A hollow wrought product of uniform cross-section with only one enclosed void along its whole length and with a uniform wall thickness.

3.2.9 *Single or Double Layer Flat Coil*

A coil in which the turns are spirally wound into disk like single or double layer (also known as pancake coil or single/double layer spirally wound coil).

4 SUPPLY OF MATERIAL

General requirements relating to the supply of material shall be as laid down in IS 1387 : 1993.

5 GRADES

This standard covers two grades of copper tubes, namely, Grade 1 and Grade 2.

6 MANUFACTURE

6.1 The tube shall be manufactured from tube shell by drawing.

6.2 The tubes shall be supplied either in soft-annealed, light annealed or light drawn condition.

6.3 The tube shall be cut to size in coil or straight length, duly drafted and sealed at both ends.

6.4 Tubes shall not be manufactured from used tubes.

7 FREEDOM FROM DEFECTS

The tubes shall be clean, smooth, free from cracks, seams, silvers, scales and other harmful defects.

8 DIMENSIONS AND TOLERANCES

8.1 Dimensions

The tubes shall be designated by the outside diameter and the wall thickness. The outside diameter, wall thickness and length shall be as ordered by purchaser from the rationalized sizes of tubes as specified in IS 5493 : 1981.

8.2 Tolerances

8.2.1 The relevant tolerances on mean outside diameter, wall thickness, straightness and length as specified in IS 5493 : 1981 shall be applicable for respective sizes.

8.2.2 The tolerances on ovality and eccentricity shall be as agreed to between the purchaser and the supplier. However, no tolerance on ovality shall be specified for tubes of wall thickness up to and including 0.4 mm.

8.2.3 The tolerances on ovality, roundness and eccentricity are applicable for light drawn tubes only. If the tubes are supplied in soft/light annealed conditions, the tolerances should be verified before heat-treatment.

8.3 Tolerance on length of tubes supplied in coil form shall be as below:

Length	Tolerance
Up to and including 30 m	+ 5 percent or 0.5 m, whichever is more - 0
Over 30 m	+ 10 percent - 0

8.4 Roundness Tolerances

The roundness tolerances on the outside diameters of tubes shall be as given below:

t/D	Tolerance, percent
0.01 to 0.03	1.5
Over 0.03 to 0.05	1.1
Over 0.05 to 0.1	0.8 or 0.5 mm, whichever is more
Over 0.1	0.7 or 0.05 mm, whichever is more

where

t = nominal wall thickness of tube, and

D = nominal outside diameter of tube.

9 CHEMICAL COMPOSITION

9.1 The chemical composition shall comply with the requirements as given in Table 1.

9.2 The chemical composition shall be determined either by the method specified in IS 440 : 1964 or any other established instrumental/chemical method. In case of dispute the procedure specified in IS 440 : 1964 shall be the referee method.

10 PHYSICAL PROPERTIES

10.1 Mechanical Properties

10.1.1 Tensile Test

A piece of tube selected for test, suitably plugged or flattened sufficiently at the ends for gripping or a strip cut from a tube, shall be tested in accordance with IS 2655 : 1964 and shall conform to the requirements of tensile properties as given in Table 2.

Table 1 Chemical Composition

(Clause 9.1)

(Composition limit are in percent maximum unless shown otherwise)

Grade	Copper*	Lead	Tin	Iron	Aluminium	Manganese	Arsenic	Nickel	Zinc	Phosphorus	T.I.†
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	99.90 Min	—	—	—	—	—	—	—	—	0.004-0.015	—
2	99.85 Min	0.01	0.01	0.03	—	—	0.05	0.1	—	0.015-0.040	0.06

* Includes silver if any.

† Total impurities.

Table 2 Tensile Properties

(Clause 10.1.1)

Condition	0.2% Proof Stress MPa	Tensile Strength MPa		Percentage Elongation on Gauge Length of 50 mm
	Min	Min	Max	Min
Soft annealed	—	205	—	40
Light annealed	—	205	—	25
Light drawn	205	250	325	—

1 MPa = 0.102 kgf/mm².

10.2 Flattening Test

10.2.1 The flattening test shall be carried out as per IS 2328 : 1983 on test pieces selected from any part of the tubes in soft annealed condition. The light annealed and light drawn tubes shall be soft annealed before testing.

10.2.2 The test piece shall not crack when close flattened until the interior surfaces of the tube meet as shown in Fig. 1.

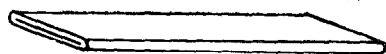


FIG. 1 FLATTENING TEST

10.3 Drift Expanding Test

10.3.1 The drift expanding test shall be carried out as per IS 2335 : 1985 on tubes in soft annealed condition. The light annealed and light drawn tubes shall be soft annealed before testing.

10.3.2 The tube shall be capable of undergoing drifting by means of a taper drift having an included angle of 60° as shown in Fig. 2, without showing either crack or flaw until the outside diameter of the expanded end measures at least 40 percent more than the original diameter of the tube. The test piece shall be examined with eyes having normal vision with or without spectacles.

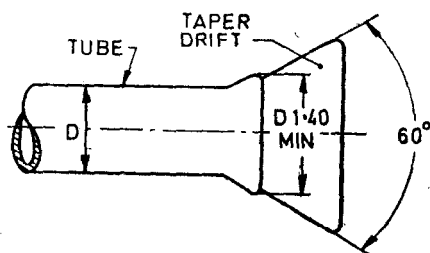


FIG. 2 DRIFT EXPANDING TEST

10.4 Non-destructive Test

10.4.0 Unless otherwise specified, manufacturer shall test the tubes as given below.

10.4.1 Eddy-Current Test

Each tube shall be subjected to the Eddy-current test in accordance with IS 11612 : 1984. Tubes shall be tested in as drawn condition prior to the final annealing or heat treatment, unless

otherwise agreed upon by the supplier and the purchaser.

10.4.1.1 The hole size shall be as agreed to between supplier and purchaser.

10.4.2 Hydrostatic Test

For tubes supplied in straight length, each tube shall be subjected to an internal hydrostatic test pressure of 7 MPa or the value given by the following formula, whichever is less, unless otherwise agreed to between the purchaser and the supplier. When subjected to the test for a minimum period of 5 seconds, the tube shall not show any sign of weeping or leaking.

$$P = \frac{Kt}{D}$$

where

P = internal hydrostatic test pressure in MPa,

$K = 130$,

t = nominal wall thickness of the tube in mm, and

D = nominal outside diameter of the tube in mm.

10.4.3 Pneumatic Test

For tubes supplied in coils, each tube shall be subjected to a minimum internal air pressure of 45 N/cm² for a minimum period of 5 seconds without showing any sign of leakage while immersed in water. This test may also be carried on tubes supplied in straight length as an alternative to hydrostatic test.

10.5 Microscopic Examination

Samples in longitudinal direction of tubes selected for the test shall be subjected to microscopic examination in accordance with IS 4748 : 1988 at a magnification of 75 X and shall show uniform and complete recrystallization with an average grain size as below:

Temper	Grain Size
Light annealed	0.015 to 0.035 mm
Soft annealed	0.035 mm, Min

10.6 Hydrogen Embrittlement Test

Test specimen of tubes shall not show any gassing or open grain structure, when examined under a microscope in accordance with IS 6243 : 1985.

11 RESIDUE TEST OR CLEANLINESS TEST

11.1 The inside of tube with sealed ends shall be sufficiently clean so that when the interior of tube is washed with trichloroethylene, carbon

tetrachloride or any other suitable organic solvent, the residue remaining after evaporation of the solvent shall not exceed 0.038 g/m² of interior surface.

11.2 To perform the test, a determined quantity of the solvent shall be taken through a tube in to a flask, which is, in turn attached to an aspirator or vacuum pump. The solvent then transferred to a weighed container (crucible, evaporating dish or beaker). The solvent in the container shall be evaporated to dryness on a low temperature hot plate or sand bath. Over heating of the container should be avoided to prevent charring of the residue. The container shall then be dried in an oven at 100-110°C for 10 minutes, cooled in a desiccator and weighed. A blank determination shall be run on the same determined quantity of solvent and the gain in weight for the blank shall be subtracted from the weight of the residue sample.

11.3 In performing the test, care shall be exercised to clean the outside surface of the end of the sample to be immersed in the solvent. The sample shall be prepared in such a manner as to prevent the inclusion in the residue of copper chips or dust resulting from the cutting of the sample.

12 SAMPLING AND CRITERIA FOR CONFORMITY

12.0 Unless otherwise agreed to between the purchaser and the supplier, the following procedure of sampling and criteria for conformity should be followed for acceptance of a lot.

12.1 Lot

In any consignment tubes of the same grade, size, thickness and temper shall be grouped together to constitute a lot of 300 tubes or 1 000 kg (whichever is higher) or part thereof.

12.2 Dimensional Tolerances

From each lot, ten tubes shall be selected at random and tested for length, outside diameter and wall thickness. No failure shall occur if the lot is to be accepted under this clause.

12.3 Chemical Composition, Mechanical Properties, Flattening Test and Drift Expanding Test

From the lot found acceptable for dimensions, one test shall be conducted for each of chemical composition, mechanical properties, flattening test and drift expanding test requirements given in the specification. The lot shall be accepted if the samples tested meet all the requirements of these tests.

12.4 Hydrostatic/Pneumatic/Eddy-Current Test

Each tube shall be tested for hydrostatic/pneumatic/Eddy-current test as prescribed in 10.4.

12.5 Microscopic Examination/Hydrogen Embrittlement Test/Residue Test

One sample from each lot shall be tested for above tests.

12.6 Retest

12.6.1 Chemical Composition

If a test result of chemical analysis fails to satisfy the requirements for any of the elements, two more tests for that element shall be done on the same sample in order to confirm that the analysis has been done properly. If both the test results satisfy the relevant requirements the lot shall be considered as conforming to the specification; otherwise not.

12.6.2 Mechanical Properties, Flattening Test and Drift Expanding Test

If the test results on any sample tested for mechanical test (tensile test), flattening test, drift expanding test, fail to satisfy the requirements for any of these tests given in the specification, two more sample shall be tested for that test. If both the test results satisfy the relevant requirement, the lot shall be considered as conforming to specification; otherwise not.

12.6.3 Microscopic Examination/Hydrogen Embrittlement Test

Should any specimen fail under above tests, all the tubes represented by the sample shall stand rejected. However, they may be resubmitted for inspection after stress-relieving treatment.

12.6.4 Residue Test

The procedure for retest shall be as agreed to between supplier and purchaser.

13 PACKING

The tubes shall be suitably covered with a polyethylene sheet and packed to avoid movements and rubbing. The tube ends shall be protected by proper inserts to avoid damage during handling and transit. Each package shall be of convenient weight for ease of handling and shall not exceed 1 000 kg (gross). The bottom of the packing case shall be rigid to enable the tubes to maintain straightness.

14 MARKING

14.1 Boxes/packages containing tubes shall be suitably marked with the following details:

- a) Lot number;
- b) Grade;

- c) Temper;
- d) Size (diameter, thickness and length);
- e) Number of tubes in the box/package;
- f) Date of manufacture; and
- g) Name and address of manufacturer.

14.2 BIS Certification Marking

14.2.1 The tubes may also be marked with the Standard Mark.

14.2.2 The use of the Standard Mark is governed by the provisions of the Bureau of Indian

Standards Act, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

15 TEST CERTIFICATE

The manufacturer/supplier should provide test certificate for each consignment giving information like grade, lot number, temper, size, thickness and corresponding chemical composition and physical properties.

ANNEX A

(Clause 2)

LIST OF REFERRED INDIAN STANDARDS

<i>IS No.</i>	<i>Title</i>	<i>IS No.</i>	<i>Title</i>
440 : 1964	Methods for chemical analysis of copper (<i>revised</i>)	4748 : 1988	Method for estimating average grain size of metals (<i>first revision</i>)
1387 : 1993	General requirements for the supply of metallurgical materials (<i>second revision</i>)	5493 : 1981	Dimensions of wrought copper and copper alloy tubes (<i>first revision</i>)
2328 : 1983	Method for flattening test on metallic tubes (<i>first revision</i>)	6243 : 1985	Method for hydrogen embrittlement test for copper (<i>first revision</i>)
2335 : 1985	Method for drift expanding test for metallic tubes (<i>first revision</i>)	11612 : 1984	Code of practice for Eddy current testing of non-ferrous seamless pipes and tubes (<i>first revision</i>)
2655 : 1964	Method for tensile testing of copper and copper alloy tubes		
3288 (Part 3) : 1986	Glossary of terms relating to copper and copper alloys: Part 3 Wrought forms		

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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Handbook' and 'Standards Monthly Addition'.

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